Quesnel Forest District

Inventory Plan

MINISTRY OF FORESTS
RESOURCES INVENTORY BRANCH
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1. INTRODUCTION

1.1 Background

The Provincial Vegetation Resources Inventory (VRI) is an improved vegetation (forest) inventory process or toolbox for assessing the quantity and quality of British Columbia's timber and other vegetation resources. It addresses the concerns expressed by the Forest Resources Commission in its 1991 report, *The Future of our Forests*. These concerns included:

- lack of statements of precision of the inventory;
- inadequate information on non-timber vegetation resources;
- lack of reliable estimates of growth rates and stand specific volumes; and
- narrow focus on commercial timber volume and the timber harvesting landbase.

The VRI can be implemented at a number of levels depending on the business needs. It can be deployed over the entire province (one or more Forest District at a time), measuring all the timber and non-timber resources. The VRI can also be deployed over a Management Unit (TFL or TSA) or a small watershed within a District, measuring selected resources in specific portions of the landbase.

The Provincial Inventory consists of a system of protocols, models and databases that can be managed through a dispersed computing environment. The Provincial Inventory process can be used to meet today's needs for timber supply, long term planning, silviculture planning, defining sustainability, public information and credibility. The Provincial Inventory can also provide data for computer modeling and decision support systems to support a baseline biodiversity assessment and for research.

The Vegetation Resources Inventory is designed to determine:

- the amount of vegetation cover in the province;
- the location of vegetation resources in the province; and
- the changes in the amount and location of vegetation resource over time.

The principles guiding the implementation of the inventory are:

- to integrate provincial inventory activities (e.g. Management Inventories, Provincial Inventory, National Forest Inventory and Monitoring);
- to implement inventory projects to satisfy business requirements as defined in the inventory plans; and
- to maximize the usefulness of sample plots and minimize overall costs by implementing a cascading plot approach that ensures that information collection meets the VRI standards while meeting multiple goals.

Management Inventories include inventories conducted in Implementation Units[1], to fulfill specific forest management or business needs. Sampling error and sampling intensity are controlled for specific vegetation attributes (e.g., timber volume) to achieve specific inventory objectives. There are several types of Implementation Units in the province: Timber Supply Areas (TSAs), Tree Farm Licenses (TFLs), and other lands (parks, private lands, and other public lands). Within (or across) these Implementation Units there may be Management Inventories addressing specific issues such as Problem Forest Types, or other strata in a TSA (or groups of TSAs).

Management Inventories are typically timber emphasis inventories. Besides providing detailed polygon information for day-to-day forest management, they can also be used to increase precision of the Provincial inventory. The TFL holders or the MoF Regions/Districts are responsible for the planning and implementation of these inventories. However, the Ministry of Forests Resources Inventory Branch requires the TFL holders or Districts to prepare an inventory business plan, which includes a sampling plan, for its approval. An inventory business plan defines the inventory needs, the information needed to meet the needs, and the methods for collecting the information. This business plan then drives the inventory project plans.

1.2 Objectives

This is a plan for implementing the Provincial Vegetation Resources Inventory and Management Inventory activities in the Quesnel Forest District in the Vancouver Forest Region. This plan was developed through consultation with various stakeholders 0n November 13, 1997 in the Quesnel Forest District, including the Ministry of Forests, Branch, Region and District staff, and the Licensees' staff from Weldwood of Canada, West Fraser mills,
C + C Wood Products, Tolko Industries, Slocan Forest Products, Canadian Forest Products, and Dunkley Lumber Ltd., who identified inventory local needs and priorities. Management issues identified in the recent TSR in the TSA were also reviewed.

The purpose of the Inventory Plan is to:

1. define the Management Inventory objectives;
2. define the Provincial Inventory strategy for Quesnel Forest District;
3. identify the inventory activities required to satisfy the objectives for both inventories; and
4. outline the implementation steps.

This plan is based on the consultant report, *Quesnel Forest District Vegetation Resources Inventory Ground Sampling Plan,* prepared by J.S. Thrower & Associates. The report was prepared following the procedures outlined in the Ministry of Forests, Resources Inventory

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[1] Implementation Units are a specified area of land such as a TSA, TFL, Innovative Forest Practices Agreement area, etc. For any Implementation Unit, there can be none to several Management Inventories based on stakeholder business needs.

Branch procedures, *Vegetation Resources Inventory: Preparing a sampling plan for ground sampling* (March 1997). The report has been reviewed by stakeholders in the District and is attached to this Inventory Plan (see Appendix A).

This Inventory Plan identifies stakeholder requirements at a given point in time. As such, it is anticipated that there will be changes to this plan. Any changes including plans that are more detailed and roles and responsibilities will be added to this plan as an addendum.

2. BUSINESS CONSIDERATIONS

2.1 Forest Management Issues

Forest management issues were identified during the recent timber supply review (Table 1). An assessment of potential impacts of the VRI ground sampling on these management issues is also shown in this table.

Table 1. Forest management issues for the Quesnel Forest District and potential impacts for VRI.

	Issue[2]	Remarks
1	Paired plot study: assess results to determine site productivity.	Measurements from Phase II plots can be used to check existing site index estimates. However, these data will not address the issue of stand productivity, or will they correct deficient site curves.
2	Site productivity: determine extent of species conversion upon regeneration.	
3	Site productivity: review information from problem-forest-type stands.	The problem forest type inventory is underway. Results should be available February 1998.
4	Re-inventory: assess new information.	Application of the Inventory.
5	Inventory audit: ratio-sampling study may help to assess the validity of the volumes for existing mature stands.	Application of the Inventory.
6	Not Satisfactorily Restocked (NSR) areas: assess and quantify into the timber harvesting landbase.	Application of the Inventory.
7	Problem Forest Types: assess and quantify the size of the PFT.	Application of the Inventory.
8	Roads, trails, landings: review and refine deduction factors.	Application of the Inventory.

[2] BC Ministry of Forests, Timber Supply Branch. 1996. Forest Management Issues Identified Through the AAC Determination Process. TSA/TFL Timber Supply Reviews: 1992-1996. 31 December 1996. Victoria BC. Pages 31-35.

	Issue[2]	Remarks
9	Regeneration, species conversion: assess and quantify extent of species conversion.	Application of the Inventory.
1	Deciduous component: assess/quantify volume of deciduous within coniferous stands.	Application of the Inventory.
1	Deciduous component: assess availability and merchantability, and quantify volume of deciduous component within the TSA.	Application of the Inventory.
		Application of the Inventory.
1	Deciduous partition: 20-year availability study will assess how much harvesting of PFT can be sustained while still meeting integrated resource management objectives.	Application of the Inventory.
1	Biodiversity.	Phase II will provide overall District totals for coarse woody debris, stumps, potential wildlife trees, and plant lists for species diversity. The precision of these totals should be evaluated by Natural Disturbance Types before being compared to the biodiversity guidelines. There is a risk that precise estimates will not be obtained for these attributes. The data can be used to identify supplemental sampling needs.
1	Decay, waste, and breakage factors for balsam and cedar forest types may be underestimated. Complete factor review is required.	Phase II data will provide information on decay and waste. Estimates of breakage are not available. Cedar net volumes are an issue in this TSA.
1	Alienation to agriculture types: assess reduction of landbase.	Application of the Inventory.
1	20-year timber availability study: assess study in light of PA obligations.	Application of the Inventory.
1	Alternatives to clearcutting: monitor use of alternative silviculture systems, mainly in mixed stands of lodgepole pine and Douglas-fir.	Application of the Inventory.
1	Environmentally sensitive areas: assess feasibility of harvesting.	Application of the Inventory.
1	Wildlife habitat: assess timber supply implications of wildlife habitat management under the CCLUP.	Plant lists, forage production, lichen production, and shrub transects from Phase II plots provide District totals, which could be used to confirm base interpretations for wildlife. Improved Phase I estimates will provide additional information on delineating wildlife habitat and protected areas.

	Issue[2]	Remarks
2	Traditional use study is currently underway.	Application of the Inventory.
2	Temporary deferral for Kluskus timber supply block: consider Part 15 Forest Act AAC reduction.	Application of the Inventory.
2	VQOs: incorporate into future TSRs.	Application of the Inventory.
2	P.A. #5 requirements: assess harvesting implications.	Application of the Inventory.
	TFL 52	
1	CCLUP/ FPC: reconsider determination if required based on future implementation of the Forest Practices Code and CCLUP.	Application of the Inventory.
2	Deciduous – aspen: develop management objectives to account for their non-timber values.	Application of the Inventory.
3	Site productivity: establish permanent sample plots in the TFL that support the provincial paired-plot survey.	Application of the Inventory.
4	Roads, trails, and landings: quantify appropriate allowances.	Application of the Inventory.
5	Silviculture treatments: treatment plan required for residual balsam stands.	Application of the Inventory.
6	Unsalvaged losses: monitor spruce leader weevil infestations and develop treatment plan.	Application of the Inventory.
7	Re-inventory required for forest cover, to be approved by the BCFS to ensure it is undertaken according to government standards.	Application of the Inventory.
8	Watershed assessments: complete Level 1 assessment required before next determination.	Application of the Inventory.
9	Decay, waste, & breakage: provincial review of factors.	Phase II data will provide information on decay and waste. Estimates of breakage are not available. The TFL is using loss factor information from the cruise database; the NVAF sampling can be used to check these estimates.
1	Biodiversity: conduct landscape-level	Phase II will provide overall District totals for coarse

	Issue[2]	Remarks
	biodiversity assessments to ensure all CCLUP targets are addressed.	woody debris, stumps, potential wildlife trees, and plant lists for species diversity. The precision of these totals should be evaluated by Natural Disturbance Types before being compared to the biodiversity guidelines. There is a risk that precise estimates will not be obtained for these attributes. The data can be used to identify supplemental sampling needs. TEM will capture some information; Phase II will confirm the TEM mapping.
	TFL 5	
1.	Environmentally sensitive areas (ESAs): terrain mapping should be completed before the next determination.	Application of the Inventory
2.	Deciduous-leading and mixed stands: management and harvesting strategy required prior to next determination.	Application of the Inventory
3.	Roads, trails, and landings: future road reductions may have been slightly overestimated.	Application of the Inventory
4.	NSR areas: assessment required on the amount of area classified as NSR, the regenerating species, the stocking levels, and growth rates on the sites.	Application of the Inventory

2.2 Inventory Issues

The following is a list of inventory issues derived from the forest management issues in the District as discussed by the stakeholders.

- Problem forest types (PFT) identification – this issue is being addressed through another inventory process currently underway.
- Beetle infestation – how much volume is affected and how is it distributed.
- Check accuracy of current photo typing (TSA).
- Check accuracy of mature and immature volumes in the TSA.
- Site productivity of regenerated stands – OGSI studies.
- Pure and mixed-deciduous stands – verify accuracy of classification and volume/decay.
- Cedar and residual Balsam (IU) stands – check decay and waste estimates.
- Green-up – need for more accurate estimates.

- Interior Douglas-Fir (IDF) stands – determine stand structure.
- Wildlife habitat – TEM mapping.
- Monitoring – standing inventory, decay, and taper.
- Need for ecological information.
- Under-estimation of heights and volumes in mature lodgepole pine stands.
- Inventory of stands left over from logging in the late 1950's and 1960's, which have resulted in uneven-aged or layered remnant stands.
- Identification of leading species in mixed spruce and lodgepole pine stands.
- TFL 5 and TFL 52 inventories (forest cover attributes) require upgrading to the provincial standards.
- Provincial and district monitoring of the indicators of sustainable forest management, as defined by the Canadian Council of Forest Ministers (CCFM).[3] Monitoring would involve measuring changes and trends in some of these indicators, which include percent and extent of area by forest type and age class, and mean annual increment by forest type and age class.
- Issues raised by the Forest Resources Commission's 1991 report, *The Future of Our Forests*, regarding the inadequacy of forest inventories in the province. These concerns included lack of statements of precision on the inventory, inadequate information on non-timber vegetation, and the narrow focus on commercial timber volume and the operable landbase.

3. INVENTORY PLAN

3.1 Provincial Inventory

3.1.1 Provincial Inventory Landbase

The inventory unit for the Quesnel VRI is the Quesnel Forest District. The total area of the Quesnel Forest District is approximately 2,111,000 ha, which includes the TSA, TFLs (within the District boundaries), and Parks (within the District boundaries).

[3] Canadian Council of Forest Ministers. 1995. Defining sustainable forest management. A Canadian approach to criteria and indicators. Natural Resources Canada. Canadian Forest Service. Ottawa, Ontario. 22 pages.

3.1.2 Objectives

3.1.2.1 Photo Interpretation

Photo interpretation work has been considered but is not recommended for the Quesnel VRI.

3.1.2.2 Ground Sampling

The purpose of VRI ground sampling is to provide overall totals and averages for timber and non-timber vegetation resources (medicinal plants and other botanical forest products) in the District. The total number of VRI sample clusters will target a ±10% sampling error (95% probability) for net timber volume in the treed portion of the District and allow for calculation of sampling errors for other VRI attributes. The key attributes of interest in the Quesnel VRI are stand age, net volume by species, and stand height. Information will be collected on all attributes, but the variability of identified key attributes will be used to set the sample size for the VRI.

3.1.3 Sampling Plan

3.1.3.1 Sample Size

To achieve the inventory objectives as identified above, the sample sizes required to implement the Provincial Inventory are summarized in Table 2. In inventory, a sampling error standard is necessary to provide a basis for determining sample size. In the VRI, the allowable sampling error standard is set at ±10% for volume estimation at the Unit/District level. This standard does not apply to other attributes in the inventory.

The number of samples required to achieve the standard is a function of the variation within the inventory unit, estimated by the coefficient of variation (CV%). The estimated CV in the Quesnel Forest District used to estimate the total number of plots to achieve a sampling error of ±10% for net volume is 60%[4]. To achieve the VRI standard at a reasonable cost, two types of VRI plots will be used:

- full VRI samples, where the full suite of information (timber, coarse woody debris, range and ecology) is collected; and
- tree emphasis samples, where only tree information is collected.

The total number of full VRI samples (70) will be adequate to achieve a sampling error of ±15% in the treed landbase. Tree emphasis samples (TEP) (70) will then be used to reduce the sampling error in the treed landbase to ±10% to achieve the standard.

In the remaining non treed area of the unit, the number of full VRI samples established will be the ratio of the treed to remaining landbase, multiplied by the number of treed VRI samples required to achieve a sampling error of ±15% (50).

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[4] The inventory audit CV was inflated by 25% to account for the possible differences between the CV estimates based on the VRI design (a tight 5-plot cluster) and based on the inventory audit (a well-distributed 9-plot cluster).

Implementing the two types of samples will ensure a minimum number of full VRI plots are established across the landscape to collect the full suite of VRI information. Establishing TEPs to boost the number of plots required to achieve the VRI standard will result in saved time and money.

To complete the Provincial Inventory, NVAF (net volume adjustment factor) and WPV (within polygon variation) sampling is required. The numbers of these types of samples are contained in Table 2.

Table 2. The estimated sample size required to implement the Provincial Inventory.

Ground Sampling Activity	Sampling Unit	VRI Samples	Tree Emphasis Samples	Sample Size
Provincial Inventory				
Vegetated Treed	Cluster	70	70	140
Other	Cluster	50	-	50
Net Volume Adjustment Factor	Trees	75		75
Within Polygon Variation	Polygon	30		30

3.1.3.2 Provincial Inventory Sampling

To achieve the Provincial Inventory objective, the sampling should be implemented in a two-step process. Step 1 is to install a approximately 100 sample clusters in the first field season over the entire District. Step 2 is to install the remaining sample clusters in the second field season. The sampling locations will be selected systematically from the sorted list of potential sampling points. This list will include all polygons in the District and will be sorted by non-vegetated/vegetated and then land type, leading tree species, age, and site index. Sampling in the first year will provide experience to refine the process for the second field season, and information to calculate precisely the remaining number of samples required to meet the precision target of ±10% for total net volume in the treed portion of the District. An estimated total of 190 sample clusters will be assumed for planning, training, and other logistic considerations. Matching unavailable sampling sites with sub-sampling of sample clusters with difficult access will be anticipated and planned for, as these activities will increase inventory costs.

A two-step approach should also be used for implementing the other ground sampling activities that support the Provincial Inventory process: NVAF sampling and WPV sampling. NVAF provides a factor to adjust the net volume from the ground sampling (derived from the net factoring process and taper equations) to account for hidden decay and possible bias in taper equations. WPV information is used to express the total error of the inventory and to indicate accuracy of individual polygon estimates. A total of 75 sample trees for NVAF sampling (selected from 15 treed and 1 non-treed polygons) and 30 sample polygons for WPV sampling are required.

3.2 Management Inventory

3.2.1 Management Unit Landbase

Management Units are separate populations created within the inventory unit (District) to control sampling error and sampling intensity for specific attributes. Six Management Inventories were identified in the Quesnel Forest District to address the inventory issues raised by the stakeholders. These Management Inventories are designed to improve the timber inventory (volume, height, and age) in the timber harvesting landbase for each of the Quesnel TSA, TFL 5 and TFL 52 and improve the timber inventory for problem forest tyoes, cedar - balsam and spruce/balsam stands, Interior Douglas-fir stands, deciduous stands and beetle infested stands. Table 3 provides an approximation of the area to be assessed by the Provincial Inventory and the Management Inventories.

Table 3. Area by Inventory Unit within the Quesnel Forest District

Inventory Type	Inventory Unit	Area (ha)
Provincial Management	Forest District	2,111,000
Quesnel TSA	Treed Landbase	1,023,000
TFL 5	Treed Landbase	32,980
TFL 52	Treed Landbase	242,730
Problem Forest Types	Treed Landbase	Not Available
Cedar, Balsam, Spruce/Balsam	Treed Landbase	Not Available
IDF Stands	Treed Landbase	Not Available
Deciduous Stands	Treed Landbase	Not Available
Beetle Infested Stands	Treed Landbase	Not Available

3.2.2 Objectives

3.2.2.1 Photo Interpretation

Photo interpretation was considered but is not being undertaken at this time.

3.2.2.2 Ground Sampling

The ground sampling objectives for the Management Inventories are to:

- *Quesnel TSA*: to improve the accuracy of timber net volume in the TSA.
- *TFL 5:* to improve the accuracy of timber net volume in TFL 52 (West Fraser Mills).
- *TFL 52*: to improve the accuracy of timber net volume in the entire TFL 5 (Weldwood of Canada).
- *Problem Forest Types*: Potential problem forest types (PFTs) in the Quesnel TSA include the lodgepole pine leading forest types and the high elevation balsam-spruce and spruce-balsam types. The inventory of some PFTs is currently under way, and will be completed by March 1998.
- *Cedar, Balsam, Spruce/Balsam*: to improve the estimates of merchantability (net volume and value) and the description of the Cedar leading, Balsam leading, and Balsam/spruce (IU) stands in the District.
- *IDF Stands*: to improve the inventory information about the Interior Douglas-fir (IDF) forest types.
- *Deciduous Stands*: to confirm the presence, location, and merchantability (net volume and value) of the pure deciduous and mixed-deciduous stands in the Quesnel Forest District.
- *Beetle Infested Stands*: to improve the estimates of total volume and its distribution in beetle-infested stands in the District.

3.2.3 Sampling Plans

To achieve the objectives of the Management Inventories, Timber Emphasis Sampling will be required. The Timber Emphasis Sampling must meet the minimum sampling requirements as specified in *Implementation Strategy to Integrate Management, Provincial and National Inventories* (MoF, Resources Inventory Branch) The supplemental sampling will involve the installation of approximately:

- 140 sample clusters in the Quesnel TSA;
- 90 sample clusters in the TFL 5;
- 50 sample clusters in the TFL 52;
- 144 sample clusters in the Problem Forest Types (already completed);
- 150 sample clusters in the Cedar, Balsam, Spruce/Balsam;
- 150 sample clusters in the IDF Stands;
- 150 sample clusters in the Deciduous Stands; and
- 150 sample clusters in the Beetle Infested Stands;

The implementation should proceed immediately in a manner similar to the Provincial Inventory Phase II sampling. The sampling will be spread over a period of 2 years, with unbiased interim results expected after the first season. Sampling in the first year will provide experience to refine the process for the second field season, and information to calculate precisely the remaining number of samples required to meet the precision target of ±10% for timber volume in the timber harvesting landbase.

NVAF sampling is not required for Management Inventories however it is strongly encouraged. Stakeholders should identify within their more detailed *Inventory Plans*[5] if NVAF sampling is to be conducted.

4. IMPLEMENTATION STRATEGY

The ground samples that are established to meet the Management Inventory objectives are compatible with the Provincial Inventory objectives providing that these dual purpose plots are identified prior to establishment. Therefore, Provincial Inventory plots will be identified prior to identifying the Management Inventory ground sampling plots. These coincident plots will be used for both the Provincial Inventory and the Management Inventory. Additional Management Inventory samples will be established to meet Management Inventory objectives. This integrated approach, that uses one set of samples to address multiple inventory needs, will result in minimum implementation costs.

There may be a need to enhance the coincident plots for non-timber attributes within the Management Inventories depending on the implementation strategy chosen. Additional

[5] Inventory Plans are required by stakeholders in order to proceed with their Management Inventories.

Provincial Inventory ground samples will need to be established in the non-Management Inventory area in order to complete the Provincial Inventory for Quesnel Forest District.

The inventory outlined above will be to the Ministry of Forests minimum standards as outlined in *Implementation Strategy to Integrate Management, Provincial and National Inventories*.

4.1 Steps

There are several ways to complete the ground sampling in the two-step process stated above. It is hoped that stakeholders will complete all the required ground sampling in a timely manner. One possible scenario is as follows:

1. Install a large number of each Management Inventory sample clusters (e.g., 100) over the entire landbase measuring *only those* tree attributes related to timber volume and site index. Install the Provincial Inventory samples for plots that are designated "multi-purpose" and install tree emphasis plots for the others. This will provide the experience to refine the process for the second field season and will provide information to calculate the required number of remaining sample clusters.
2. Install the remaining Management Inventory sample clusters in the second field season. (Note: the stakeholder may choose to install all ground samples in one field season).

4.1.2 Implementation Process

The implementation process will proceed based on available funding and can be implemented based on a number of scenarios. All implementation scenarios will a common process. One possible implementation process will proceed as follows:

1. Assemble all polygons within the District into one list; check to ensure no areas are missing or double counted.
2. Sort the polygon list according to the criteria: BC Land Cover Classification code, estimated leading tree species, age and site index.
3. Select potential sampling points from the sorted list, as described in the Ministry of Forests, Resources Inventory Branch document, *Vegetation Resources Inventory: Preparing a sampling plan for ground sampling*.
4. Stratify list to *vegetated treed* and *remaining area* (non-vegetated, vegetated non-treed).
5. Systematically select the Provincial Inventory samples by stratum.
6. Systematically select the polygons for the within polygon variation sampling from the list of Provincial Inventory samples.
7. Systematically select the 16 NVAF sample points (15 treed and 1 non-treed whether or not volume is indicated) from the Provincial Inventory ground samples.

8. Stratify the District to determine the Provincial Inventory samples that meet Management Inventory objectives. Subtract this number of samples from the total required for each Management Inventory. Select the remaining number of Management Inventory samples for each unit.
9. For the Management Inventory, systematically select a batch of sampling points from the list of operable sampling points (80% of the sample size) and from the list of inoperable sampling points (20%).
10. Begin planning for field sampling.
11. Prepare a field sampling plan that includes sample cluster batches to ensure an unbiased sample is attained at the end of the first field season. Identify NVAF sample points and ensure they are field sampled early in the field season.
12. Locate and measure ground sample clusters.
13. Monitor quality assurance of field data and procedures during field sampling. Arrange for 'audit quality cruisers' to sample auxiliary plots of NVAF samples.
14. Compile the data in the fall and winter of the first year. This will include computing averages of timber volume, basal area, and regression of photo estimated volume to ground sample volume and the associated standard error of the regression.
15. Prepare NVAF tree sampling matrix. Begin NVAF destructive sampling.
16. Prepare for the second step during the winter. This will include calculation of the CV based on the standard error of the regression. The remaining number of samples required to achieve the stated desired precision can then be accurately determined using standard procedures (see Appendix B).
17. Prepare the remaining samples.
18. Locate and measure remaining ground sample clusters in the second field season. Complete stem analysis of the NVAF sample trees. Complete the within polygon variation sampling.
19. Compile all data, do the statistical adjustments and load final inventory results into the provincial database.

4.2 Cost

4.2.1 Provincial Inventory

The Provincial Inventory costs, for planning purposes, are summarized in Table 4.

Table 4. Estimated costs required to complete the Provincial Inventory sample plan.

Ground Sampling Unit	Sample size	Unit Cost* ($)	Total Cost ($)
Provincial Inventory			
Sample Cluster (VRI)	120	2,500	300,000
Sample Cluster (tree only)	70	1,500	105,000
Net Volume Adjustment Factor – (tree)	75	500	37,500
Within Polygon Variation	30	1,500	45,000
Total			487,500

* The unit costs are based on experience gained from the Boston Bar Operational Trial.

A CV of 60% and the objective precision level of ±10% sampling error (at the 95% probability level) were used to estimate the required number of Provincial Inventory samples.

Sampling efficiency and cost effectiveness will be achieved by implementing the Provincial Inventory ground sampling in combination with the Management Inventory sampling. Results of the VRI ground sampling can be evaluated to determine the additional sampling required to meet the specific objectives.

4.2.2 Management Inventory

The costs for completing the Management Inventory plan, including the incremental cost of establishing the Provincial Inventory ground samples, are identified in Table 5.

Table 5. Estimated costs required to complete the Management Inventory sample plan.

Ground Sampling Unit	Sample size	Unit Cost ($)	Total Cost ($)
Management Inventory			
Quesnel TSA	140	1,500	210,000
TFL 5	90	1,500	135,000
TFL 52	50	1,500	75,000
Problem Forest Types	144	Finished*	0
Cedar, Balsam, Spruce/Balsam	150	1,500	225,000
IDF Stands	150	1,500	225,000
Deciduous Stands	150	1,500	225,000
Beetle Infested Stands	150	1,500	225,000
Total			1,320,000

* Ground sampling completed in 1997, report available in March, 1998.

The sample size determination for the Management Inventory sampling can be found in the consultant report, *Quesnel Forest District Vegetation Resources Inventory Ground Sampling Plan, Revised Final Report* (Appendix A). The required number of

Management Inventory samples is based on the appropriate CV (estimated) and the objective precision level of ±10% sampling error (at the 95% probability level).

4.2.3 Combined Management Inventory and Provincial Inventory

Implemented separately, the total cost of the Provincial Inventory and the Management Inventories would be approximately $1,807,500. Combining the inventory objectives through a common implementation strategy will realize a saving. Given the multiple Management Inventories within the Williams Lake TSA and their overlapping areas, it is difficult to estimate the magnitude of these savings. However, the savings on the Provincial Inventory samples would be approximately $210,000 based on implementing all of the vegetated treed VRI and tree emphasis samples in combination with the Management Inventory plots.

Table 6 illustrates the cost for one possible implementation scenario where overlap occurs between one of the Management and the Provincial Inventory. The total cost could be higher or lower if the assumptions stated above are not valid. For example, an increase in the CV or a reduction in the desired precision level will result in an increase in the number of samples required to achieve the objectives. The relationship between the sampling error and sample size is illustrated in the contractor report (Appendix A).

Table 6. Combined costs to complete the Management and Provincial Inventory sample plans.

Ground Sampling Unit	Sample size	Unit Cost ($)	Total Cost ($)
Management Inventory			
Quesnel TSA	140	1,500	210,000
TFL 5	90	1,500	135,000
TFL 52	50	1,500	75,000
Problem Forest Types	144	Finished*	0
Cedar, Balsam, Spruce/Balsam	150	1,500	225,000
IDF Stands	150	1,500	225,000
Deciduous Stands	150	1,500	225,000
Beetle Infested Stands	150	1,500	225,000
Incremental Provincial Inventory Ground Samples			
Sample Cluster (upgrade to full VRI)	70*	1,000	70,000
Sample Cluster (tree only)	70*	0	0
Provincial Inventory (Remaining)			
Sample Cluster (VRI)	50	2,500	125,000
Sample Cluster (tree only)	0	1,500	0
Net Volume Adjustment Factor - Tree	75	500	37,500
Within Polygon Variation	30	1,500	45,000
Total			1,597,500

*Tree information component to be captured as part of the Management Inventory sample

The total cost could be higher or lower if the assumptions stated above are not valid. For example, an increase in the CV or a reduction in the desired precision level will result in

an increase in the number of samples required to achieve the objectives. The relationship between the sampling error and sample size is illustrated in the contractor report (Appendix A).

Depending on the implementation strategy, the savings will vary. The savings realized reflect the comparative overlaps of the Management Inventories. The numbers in Table 6 reflect one possible implementation scenario. Costs will change depending on the actual implementation scenario chosen.

4.3 Monitoring

The Ministry of Forests, Resources Inventory Branch is responsible for monitoring this Inventory Plan.

5. APPROVAL/SIGNING

I have read and concur with the Quesnel Forest District Inventory Plan, June 1, 1998. It is understood that this is an agreement-in-principle and does not commit the signatories to completing the inventory activities outlined within the plan. Modifications to this plan or more detailed plans need to be reviewed and approved by the signatories and then appended to this plan.

District Manager Quesnel Forest District	MacMillan Bloedel
Regional Manager Vancouver Forest Region	Scott Paper
Director Resources Inventory Branch	International Forest Products
Western Forest Products	TimberWest Forest Products
Canadian Forest Products	

Appendix A

Quesnel Forest District
Vegetation Resources Inventory
Ground Sampling Plan

Appendix B

Polygon Selection